

## PATENT ABSTRACTS OF JAPAN

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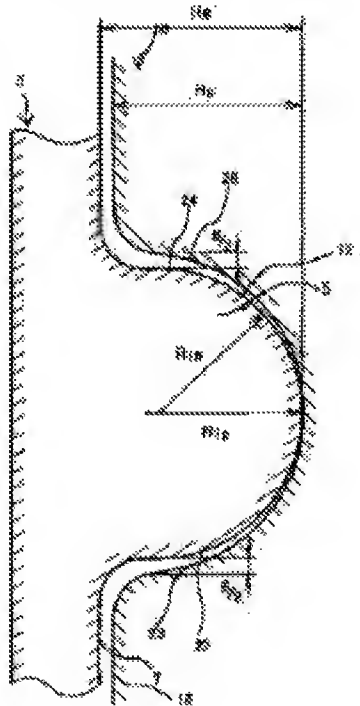
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### (54) COMBINATION DEVICE OF TOOTHED BELT AND PULLEY



(57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a combination device of a toothed belt and a pulley which is prepared by compressively engaging a belt tooth part with a belt groove part, reduced in abnormal noises while keeping durability by specifying a compressive ratio of the belt tooth, and by specifying a backlash rate between the belt tooth and the pulley tooth groove.

**SOLUTION:** A belt tooth part 5 and a pulley groove part 12 each have a shape composed of two circular arcs, and tangential lines connecting them to each other. The belt tooth part 5 has a compression ratio of 2 to 4% when it is compressively engaged with the pulley groove part 12. The rate of backlash between the belt tooth part 5 and the pulley groove part 12 ranges between 11% and 14% of tooth width W of the belt tooth part 5.

[Claim 1] While equipping one driven shaft with a belt pulley which has a slot and a tooth part by turns at least with a driving shaft, respectively, In a combination device of a toothed belt and a belt pulley which pass a toothed belt over these belt pulleys, make height of a belt tooth part larger than the depth of

a pulley groove, and make a pulley groove come to carry out compression engagement of the belt tooth part, Each of a toothed belt and a belt pulley has a longitudinal section outline, and it comes to contain 2 circles in the longitudinal section outline at least, It is connected with each tangent between the 2 above-mentioned circles, and a belt tooth part carries out compression engagement with a compression ratio of 2 to 4% between the above-mentioned belt tooth part and a pulley groove further, A combination device of a toothed belt, wherein the maximum of a backlash between the above-mentioned belt tooth part and a pulley groove is 11 to 14% of range to a face width of a belt tooth part, and a belt pulley.

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[Translation done.]

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the combination device of the belt which can reduce pronunciation, and a belt pulley by starting the toothed belt used for the automobile engines for an overhead-camshaft drive etc., and the toothed pulley which gets into gear to it, and giving the compression ratio of a specific backlash and a belt tooth part, and a pulley groove.

[0002]

[Description of the Prior Art] This toothed belt consists two or more tooth parts allocated in accordance with the length direction, and a cable core of a tooth cloth which covers burial \*\*\*\*\*, and the tooth part surface and a bottom part. The toothed belt of a short pitch [ like 8.0 mm or 9.525 mm ] whose tooth part pitch is is mainly used for cars like the object for an overhead-camshaft drive, etc.

[0003] In recent years, the load applied to a belt with the rise of the operating environment temperature of a toothed belt is also increasing with an engine high increase in power and high-rotational-izing. The highly efficient toothed belt corresponding to such demand quality is being developed, and the demand especially to an allophone is also becoming severe in recent years. The basic performance of a toothed belt also has a case which is not adopted for an allophone even if good, and improvement of an allophone has an important meaning.

[0004] Usually, since the conditions which an allophone generates are restricted comparatively, in the case of a general industrial use way, they are removing a specific number-of-rotations belt, and can perform improvement of an allophone comparatively easily, for example. However, since the range of the number of rotations used is wide in for cars, it is not only removing specific number of rotations, and fundamental solution is needed. That is, it is necessary

to provide a means to suppress generating of an allophone as the toothed belt itself or a belt drive system.

[0005]

[Problem(s) to be Solved by the Invention]As a mechanism of generating of the allophone of a toothed belt, impulse force in case the gear tooth of a belt pulley gears with the gear tooth of a toothed belt serves as a source of excitation, and it thinks for a belt body to carry out a string oscillation. Therefore, it is reducing impulse force as an effective measure to allophone dissolution, and, for that purpose, there are a method of reducing the impulse force itself, and the method of absorbing impulse force. The former is the method of improving the size of a toothed belt or a belt pulley and improving the engagement state of a toothed belt and a belt pulley, and the latter is the method of rationalizing the material of a toothed belt or a belt pulley.

[0006]The place which this invention makes the purpose in light of the above-mentioned problems, When a belt tooth gears with a belt pulley tooth space and a fixed compression amount by making the height of a belt tooth, and the depth of a belt pulley tooth space into a specific ratio, Pronunciation is reduced maintaining endurance and reduction of pronunciation is further aimed at by considering it as the range whose backlash quantity of a belt tooth and a belt pulley tooth space is also still more specific.

[0007]

[Means for Solving the Problem]While an invention of Claim 1 which solves an aforementioned problem equips one driven shaft with a belt pulley which has a slot and a tooth part by turns at least with a driving shaft, respectively, In a combination device of a toothed belt and a belt pulley which pass a toothed belt over these belt pulleys, make height of a belt tooth part larger than the depth of a pulley groove, and make a pulley groove come to carry out compression engagement of the belt tooth part, Each of a toothed belt and a belt pulley has a longitudinal section outline, and it comes to contain 2 circles in the longitudinal section outline at least, It is connected with each tangent between the 2 above-mentioned circles, and a belt tooth part carries out compression engagement with a compression ratio of 2 to 4% between the above-mentioned belt tooth part and a pulley groove further, The maximum of a backlash between the above-mentioned belt tooth part and a pulley groove is in a combination device of a toothed belt being 11 to 14% of range, and a belt pulley to a face width of a belt tooth part.

[0008]It is connected with each tangent between 2 circles which form a belt tooth part, Furthermore, a belt tooth part carries out compression engagement with a compression ratio of 2 to 4% between the above-mentioned belt tooth part and a pulley groove, While stress distribution concerning a belt tooth part is fully performed from the maximum of a backlash between the above-

mentioned belt tooth part and a pulley groove being 11 to 14% of range to a face width of a belt tooth part, Reduction of pronunciation is achieved and reduction of pronunciation can be further aimed at by considering it as a range whose backlash quantity of a belt tooth and a belt pulley tooth space is also still more specific.

[0009]

[Embodiment of the Invention] Hereafter, the embodiment of this invention is described based on Drawings. Similarly drawing of longitudinal section showing the engagement state to the belt pulley of one belt tooth part of the device which requires drawing 1 for this invention, drawing of longitudinal section of the tooth part of the piece of the toothed belt which drawing 2 uses for this device, and drawing 3 are drawings of longitudinal section of the slot of the piece of a belt pulley. Drawing 5 is a perspective view showing the composition of a toothed belt. The toothed belt 3 used by this invention consists of composition which covered the tooth cloth 8 on the surface of two or more belt tooth parts 5 arranged by turns in accordance with the length direction as shown in drawing 5, the belt slot 7, the regions of back 2 under which the cable core 6 was laid, and the belt tooth part 5 and the belt slot 7.

[0010] This belt tooth part 5 is the sectional shape shown in drawing 2.

According to this, the belt tooth parts 5 are round teeth which consist of the tangent 13 which connects the circle of curvature-radius  $R_B$  which has a starting point and forms the tip part 9 on the center line of the belt tooth part 5, the circle, and two circles of curvature-radius  $r_B$  which forms the root-of-tooth part 11.

[0011] The raw material rubber used said tooth part 5 and back [ 2 ], Rubber, the crude rubber and styrene butadiene rubber, nitrile rubber, etc. by which heat-resistant aging nature, such as chloroprene rubber including hydrogenated nitrile rubber, chlorosulphonated polyethylene (CSM), and alkylation chlorosulphonated polyethylene (ACSM), has been improved are used.

[0012] As the above-mentioned cable core 6, what twisted the 5-9-micrometer filament of E glass or high intensity glass is processed with the RFL liquid etc. which are the protecting agent or adhesives which consists of rubber compositions. the Para system aramid fiber (trade name: -- Kevlar.) with elongation small to stress as organic textiles, and large tensile strength The 0.5-2.5-denier filament of theque NORA is twisted, and the twist code processed with the adhesives of RFL liquid, an epoxy solution, an isocyanate solution, and a rubber composition is used. However, in this invention, it is not limited to these.

[0013] The sail cloth used as a tooth cloth is 6 nylon, 66 nylon, polyester, an aramid fiber, etc., is independent or may be mixed. The composition of the warp (belt width direction) of a tooth cloth or the woof (the belt length

direction) is also filament yarn or cotton yarn of said textiles, and, as for either, \*\*\*\*\* is also good at a plain weave fabric, a twill fabric, and a satin fabric. It is preferred to use some urethane elastic yarn which has elasticity for the woof.

[0014]The belt pulley 10 used here has the pulley groove 12 and the belt pulley tooth part 14 which gear to the belt tooth part 5 and the belt slot 7. The pulley groove 12 shown in drawing 3 consists of the belt pulley bottom 17 of the circle formed from curvature-radius  $R_p$  which has the starting point 15 on the center line 1, and the belt pulley side 16 mostly formed from a straight line.

[0015]The belt pulley tip part 18 consists of a circle formed from curvature-radius  $r_p$  with the starting point 19. The belt pulley side 16 serves as a tangent of the circle which forms the belt pulley bottom 17, and the circle which forms the belt pulley tip part 18.

[0016]Height  $H_B$  of the belt tooth part 5 is larger than depth  $H_P$  of the pulley groove 12, and when tension is added, the belt tooth part 5 and the pulley groove 12 carry out compression engagement, as the engagement of that the engagement state of the above-mentioned pulley groove 12 and the belt tooth part 5 is static and linear shape is shown in drawing 1. A compression ratio is computed by  $(H_B - H_P) / H_B \times 100$  (%).

[0017]In the case of the dynamic engagement of the above-mentioned pulley groove 12 and the belt tooth part 5, as shown in drawing 4 (a) - (c), while the belt slot 7 and the pulley tip part 18 contact by compressing the belt tooth part 5 in the pulley groove 12, the engagement of a belt and a belt pulley is performed.

[0018]In [ an artificer's backlash quantity of the conventional toothed belt is small here, and ] the dynamic engagement (drawing 4 (a) - (c)) of the toothed belt 3 and the toothed pulley 10 for the reason, Although the belt tooth 20 which has geared with the belt pulley thoroughly did not have the engagement top problem with a belt pulley, the belt tooth 21 used as an imperfect engagement part traced that the front belt side 22 of the belt ternary line writing direction interfered with the belt pulley side 23, and had made pronunciation.

[0019]If the above-mentioned phenomenon is explained in detail, when the toothed belt 3 will get into gear to the toothed pulley 10 in drawing 4, at the beginning of the engagement. When the belt pulley tip part 18 of the toothed pulley 10 gears with the belt tooth part 5 of the toothed belt 3 from drawing 4 (a) to drawing 4 (b), it interferes each other, and the belt pulley tip part 18 pushes up the belt tooth part 5, and vibrates the straight part of the toothed belt 3. And when this vibration is periodically added to the toothed belt 3 and this excitation cycle is in agreement with the character frequency of the toothed belt 3, a string oscillation is amplified by resonance and it pronounces.

[0020]In order to solve the above-mentioned problem, the artificer reached that it was required to intercept impudence of excitation and to lessen frictional

force to a belt tooth and modification extremely, without lowering endurance. [0021]It is that the belt side 13 does not contact the belt pulley side 16 by the power more than needed to intercepting impudence of the above-mentioned excitation. For that purpose, it is required for a belt tooth part to go into a pulley groove smoothly, when a pulley groove gears with a belt tooth part, and for a belt tooth part to go away from a pulley groove smoothly. For that purpose, by making the backlash between a belt tooth part and a pulley groove into optimum dose showed that the engagement of the above-mentioned belt tooth part and a pulley groove became smooth, and excitation was not puffed up. Gearing, while both the belt sides 22 and 24 of the belt tooth part 5 interfere in both the belt pulley sides 23 and 25 of the belt pulley tooth space 12 here by making backlash quantity B into 11 to 14% of range to the face width W of the belt tooth part 5 in drawing 1 is lost, It is lost that excitation is puffed up.

[0022]And when the above-mentioned backlash quantity is smaller than 11%, the belt side 22 by the side of before [ of the belt tooth part 5 ] a direction of movement interferes with the belt pulley side 23 of the pulley groove 12, It will get impudent, and on the other hand, if backlash quantity exceeds 14%, the belt side 24 on the backside [ a direction of movement ] of the belt tooth part 5 interferes with the belt pulley side 25 of the pulley groove 12, and excitation will be pronounced.

[0023]Next, in order to reduce the frictional force at the time of an engagement with the belt pulley in a belt tooth point, it is necessary to make the compression amount of a belt as small as possible but, and. When a belt tooth point was kept from contacting a belt pulley tooth space pars basilaris ossis occipitalis, it traced that the beat sound in a belt bottom part and a belt pulley tip part occurred, and the stress further applied to a belt tooth part was not distributed, but endurance worsened.

[0024]Then, when a pulley groove geared with a belt tooth part by making the above-mentioned compression ratio into optimum dose, the frictional force of a belt tooth point and a belt pulley tooth space pars basilaris ossis occipitalis became very small, and the artificer found out the compression ratio of the belt tooth part which can also distribute the stress further applied to a belt tooth part. That is, as the above-mentioned compression ratio, 2% - 4% have the optimal compression ratio of the belt tooth part 5.

[0025]When the compression ratio of the belt tooth part 5 is smaller than 2% as the above-mentioned compression ratio, stress dispersion does not become good, but stress concentrates on the root-of-tooth part 11 of a belt, and it becomes early lives, such as a root-of-tooth crack, here. On the other hand, with the above-mentioned compression ratio, when the compression ratio of the belt tooth part 5 is larger than 4%, it will be the cause of pronunciation [ apply / too much / the compression ratio of the belt tooth part 5 becomes large too

much, and / to the bottom of the belt tooth part 5 / frictional force ] of the frictional force.

[0026]

[Example]200MY20 was used as belt size as working example, and 3 mm and the belt pulley tooth space depth were belt-tooth height 2.91 mm. The compression ratio at this time was 3%. As a conventional example, it was a belt of the same size, and 3.13 mm and the pulley groove depth were 2.91 mm about belt-tooth height. The compression ratio at this time was 7%. At this time, the maximum of the backlash was [ as opposed to / in working example and a conventional example / the face width of a belt tooth part ] 13%. The belt as furthermore shown in Table 2 as a comparative example was produced.

[0027]To the next, measurement by tracking analysis of pronunciation was carried out by the belt of working example and a conventional example. As a test condition, the sweep was carried out from the maximum engine speed to the idling engine speed, and pronunciation was measured. Furthermore, the microphone for pronunciation measurement was installed in the engine upper part, applied the sound incorporated from the microphone for pronunciation measurement to FFT, and conducted tracking analysis of pronunciation. A test layout is shown in drawing 6. In 24 gear teeth and the cam pulleys 31 and 34, a number of teeth here the crank pulley 30 48 gear teeth, the idler pulley 36 -- the path was  $\phi 74.2\text{mm}$  and, as for  $\phi 60\text{mm}$  and the auto tensioner 33, the path was [ 24 gear teeth and idler pulleys 32 and 37 / the path of the water-pump side idler 35 ]  $\phi 60\text{mm}$ .

[0028]Here, the number of rotations of the crank pulley 33 was changed to 800 rpm - 6000 rpm. The belt always applied the tension of 30kgf by the auto tensioner. It measured by furthermore installing a microphone in the place separated from the crankshaft 30 cm. A result is shown in drawing 7. Here, the fact that a common rotational area is 1000-3000 rpm shows that the pronunciation in a common rotational area is reducing working example compared with a conventional example.

[0029]Next, it stood on the place which set driving pulley number of rotations to 1000 rpm with the same layout, and is distant from an engine 50 cm, and audibility was evaluated. The result is shown for the grade of marks in Table 1 in Table 2.

[0030]

[Table 1]

評点	程度
5	全く聞こえない
4	聴診器でないとケルケル、ウルウルが聞こえない
3	ケルケル、ウルウルと聞こえる
2	ケルケル、ウルウルと良く聞こえる
1	ケルケル、ウルウルとやかましい

[0031]

ベルト	圧縮率 (%)	ベルト歯部の歯幅に対するバックラッシュの最大値 (%)	聴感
実施例 1	3	13	3.5
実施例 2	2	11	3.5
実施例 3	4	14	3.5
従来例	7	13	2.0
比較例 1	4.9	13	3.0
比較例 2	1.5	13	3.0
比較例 3	3	10	2.5
比較例 4	3	15	2.5

[Table 2]

[0032]As for it, compared with the comparative examples 1-4, as Table 2 shows, working example turns out that grugru and the Ur Ur sound can hardly be heard. Furthermore as for a far large conventional example, a compression ratio can be heard as well as grugru and Ur Ur, and pronunciation is large considerably.

[0033]

[Effect of the Invention]By this invention, between 2 circles which form a belt tooth part is connected with each tangent as mentioned above, Furthermore, a belt tooth part carries out compression engagement with the compression ratio of 2 to 4% between the above-mentioned belt tooth part and a pulley groove, While stress distribution concerning a belt tooth part is fully performed from the maximum of the backlash between the above-mentioned belt tooth part and a pulley groove being 11 to 14% of range to the face width of a belt tooth part, Reduction of pronunciation is achieved and there is an effect that reduction of pronunciation can be aimed at further, by considering it as the range whose backlash quantity of a belt tooth and a belt pulley tooth space is also still more specific.

[Brief Description of the Drawings]

[Drawing 1]It is drawing of longitudinal section showing the engagement state to the belt pulley of one belt tooth part of the device concerning this invention.

[Drawing 2]It is drawing of longitudinal section of the tooth part of the piece of the toothed belt used for the device of this invention.

[Drawing 3]It is drawing of longitudinal section of the slot of the piece of the belt pulley used for the device of this invention.

[Drawing 4]the dynamic engagement of a toothed belt and a belt pulley -- a table -- the bottom is a figure and signs which go to (c) from (a) that it is alike, and follow and it shifts to a perfect engagement from an imperfect engagement are shown.

[Drawing 5]It is a perspective view showing the composition of the toothed belt



used for the device of this invention.

[Drawing 6] It is a layout pattern of a speech test.

[Drawing 7] It is a tracking analysis result of pronunciation.

[Description of Notations]

1 A combination device of a toothed belt and a belt pulley

2 Belt regions of back

3 Toothed belt

5 Belt tooth part

6 Cable core

7 Belt slot

8 Tooth cloth

9 Tip part

10 Toothed pulley

11 Root-of-tooth part

12 Pulley groove

13 Belt side

14 Belt pulley tooth part

16 Belt pulley side

17 Belt pulley bottom

18 Belt pulley tip part

19 Starting point

22 Belt side

23 Belt pulley side

24 Belt side

25 Belt pulley side

W Face width

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[Translation done.]